SPECIFIED GAS EMITTERS REGULATION

QUANTIFICATION PROTOCOL FOR AEROBIC COMPOSTING PROJECTS

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Version 1.1

Alberta

ALBERTANS & CLIMATE CHANGE

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The information provided in this document is intended as guidance only and is subject to revisions as learnings and new information comes forward as part of a commitment to continuous improvement. This document is not a substitute for the law. Please consult the *Specified Gas Emitters Regulation* and the legislation for all purposes of interpreting and applying the law. In the event that there is a difference between this document and the *Specified Gas Emitters Regulation* or legislation, the *Specified Gas Emitters Regulation* or the legislation prevail.

All Quantification Protocols approved under the *Specified Gas Emitters Regulation* are subject to periodic review as deemed necessary by the Department, and will be re-examined at a minimum of every 5 years from the original publication date to ensure methodologies and science continue to reflect best-available knowledge and best practices. This 5-year review will not impact the credit duration stream of projects that have been initiated under previous versions of the protocol. Any updates to protocols occurring as a result of the 5-year and/or other reviews will apply at the end of the first credit duration period for applicable project extensions.

Any comments, questions, or suggestions regarding the content of this document may be directed to:

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1.0 PROJECT AND METHODOLOGY SCOPE AND DESCRIPTION

This quantification protocol is written for the aerobic composting project developer. Some familiarity with or general understanding of, waste management practices including aerobic composting is expected.

The opportunity for generating carbon offsets with this protocol arises from directly avoiding methane emissions from materials anaerobically decomposed in landfills. Specifically, this protocol covers the diversion of organic residues from landfill for biological decomposition to a condition sufficiently stable for nuisance-free storage and for safe use in land application.

1.1 Protocol Scope and Description

An aerobic composting project will achieve GHG reductions/removals primarily through the diversion of the organic residues from landfill; avoiding methane production from anaerobic decomposition. This protocol will apply, regardless of historical practices associated with a composting facility. This approach, termed as the ***adjusted baseline approach,*** accounts for carbon gains from current adoption levels of composting practices in Alberta, adjusted based on waste composition data and activity levels from Statistics Canada, NRCan and other regional waste characterization studies. This value has been set at 20% based on the levels of organic residues diverted from landfills for composting operations in Alberta in the 2002 timeframe. This value will be applied to all composting projects applying this protocol (see the Protocol Applicability section for more interpretation).

Given the potential range of materials, processes and technologies that may be applied, this protocol serves as a generic 'recipe' for project developers to follow in order to meet the measurement, monitoring and GHG quantification requirements. **FIGURE 1.1** offers a process flow diagram for a typical project.

Protocol Approach:
In practice, there is considerable potential to divert streams of organic residues from landfill towards higher value and less greenhouse gas emission intensive end use. The baseline condition for projects applying this protocol is that the organic residues are being collected, handled and disposed of in a landfill (controlled or uncontrolled) such that anaerobic decomposition would typically occur except for a fraction of wastes that would have been diverted regardless. In order to make the default approach feasible and credible, it is necessary to create baseline deductions that are regionally aggregated. In other words, all project facilities receive the same factor for fraction of waste already diverted from landfill under the baseline regardless of whether facilities were operational in the past. As such this protocol strives to simplify and minimize project administrative costs by not having to collect and analyze historical information for composting projects. Project

developers will however have to demonstrate that their operations began either pre-2002 or post 2002 – see next section).

A broad variety of organic residues are considered, including agricultural and agri-food residues, the organic portion of municipal solid waste, food wastes, forestry and landscaping wastes, etc. **FIGURE 1.2** offers a process flow diagram for a typical baseline configuration.

Protocol Applicability:
Composting of manure is specifically excluded from quantification under this protocol due to a lack of scientific understanding of the nitrous oxide emissions[1]. Mixed streams, which include manures, may still be contemplated for this protocol, but, the manure portion of the stream must be excluded from the calculations. In order for this protocol to apply to cases where project developers are utilizing manures to adjust C:N ratios or for some other purpose, they would need to demonstrate that the manure streams are less than 50% of the mix, by weight. At values higher than this, it would be considered a manure composting operation and ineligible under this protocol.

Further, it is not appropriate to apply this protocol to projects that involve any anaerobic processes within the composting operation, where treatment is not sufficient to generate mature compost or where the organic residue was not diverted from landfill. While some procedures in this protocol may be transferable to such projects, there would be considerable differences which would lead to inaccuracy in the quantification of the GHG emission reductions.

[1] Upon further research, these may be included such that the emissions of nitrous oxide during composting are better understood to prevent overestimation of the emission reductions for projects composting manure.

FIGURE 1.1: Process Flow Diagram for Project Condition

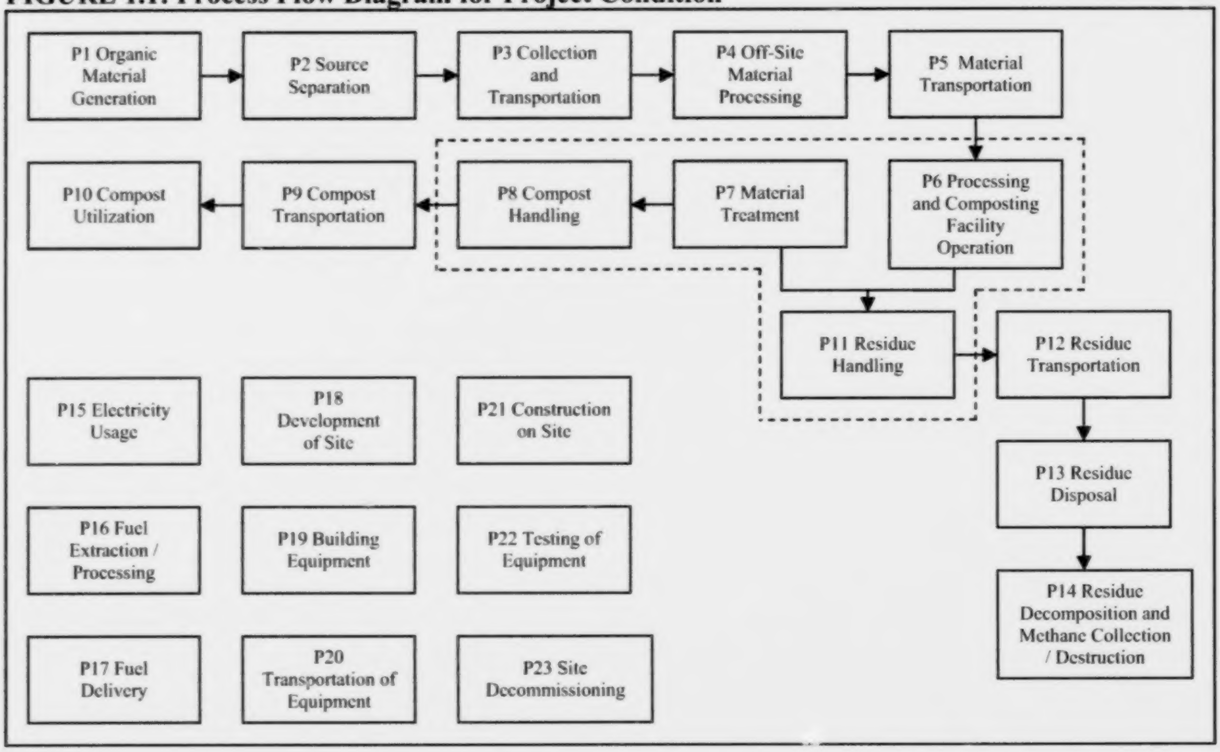
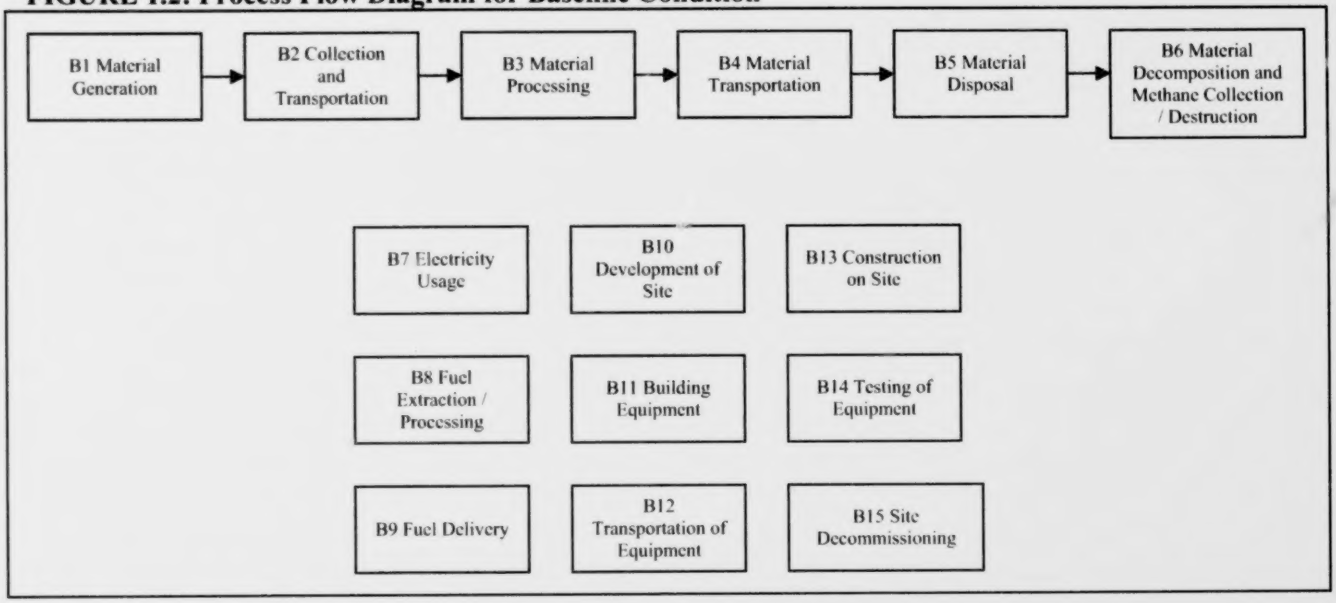


FIGURE 1.2: Process Flow Diagram for Baseline Condition



To demonstrate that a project meets the requirements under this protocol, the project developer must supply sufficient evidence to demonstrate that the following applies:

1. The materials being diverted to the aerobic composting operation would otherwise be landfilled as confirmed by disposal records or other means;
2. For Projects starting prior to 2002[2], the adjusted baseline is applied, and the crediting date for which offset credits are calculated and can be earned begins January 1, 2007 (the year in which the Alberta Specified Gas Emitter Regulation took effect);
3. For Projects starting after 2002 (as per the Offset Project Guidance Document interpretation) the adjusted baseline is again applied, but in this instance, the crediting date for which offset credits are calculated and can be earned would be anytime after the start date of the Project (i.e. sometime post 2002);
4. The organic residue must be treated to the point of being mature as per the requirements of Canadian Council of Ministers of the Environment (CCME) for maturity and destruction of pathogenic organisms as per facility operating permits or other third party analysis;
5. The quantification of reductions achieved by the project is based on actual measurement and monitoring (except where indicated in this protocol) as indicated by the proper application of this protocol; and,
6. The project must meet the requirements for offset eligibility as specified in the applicable regulation and guidance documents for the Alberta Offset System. Of particular note:
    a. The project must have received its first batch of feedstock, other than feedstock used for a testing phase, on or after January 1, 2002 as indicated by facility records;
    b. The project may generate emission reduction offsets for a period of 8 years unless an extension is granted by Alberta Environment, as indicated by facility and offset system records. Additional credit duration periods require a reassessment of the baseline condition; and,
    c. Ownership of the emission reduction offsets must be established as indicated by facility records.

Protocol Flexibility:
Flexibility in applying the quantification protocol is provided to project developers in four ways.

1. There will be some sequestration of carbon within the compost. There may also be emissions of methane and nitrous oxide from its use. The net emissions of greenhouse gases are difficult to quantify and likely negligible for most end-uses of compost.

[2] Based on the date the first batch of feedstock arrived at the site that was not part of a testing phase, as per the Offset Project Guidance Document for Alberta. In the context of bullets 2 and 3 above in the Protocol Applicability section, the full crediting period would hold for all eligible projects.

However, the project developer may wish to include these elements in the analysis. The analysis must include all elements and must trace the compost through to its end use;

2. Organic materials that are being land applied on agricultural lands may be excluded from the requirement to meet CCME guidelines for maturity. However, it must be demonstrated by the proponent that this material will not be stored in conditions that would allow for anaerobic conditions to develop;
3. Site specific emission factors and other project specific factors (i.e. relevant landfill characteristics) may be substituted for the generic emission factors indicated in this protocol document. The methodology for generation of these emission factors must be sufficiently robust as to ensure reasonable accuracy; and
4. The project proponent may provide other evidence to demonstrate that the compost is mature. Or, alternatively, they may demonstrate that the compost is of such a quality that the underlying principles of the protocol remain assured and that there is no risk of over-estimating the emission reductions.

If applicable, the proponent must indicate and justify why flexibility provisions have been used.

1.2 Glossary of New Terms

Functional Equivalence	The Project and the Baseline should provide the same function and inputs and outputs (i.e. metered landfill gas, or gas produced from aerobic composting). This type of comparison requires a common metric or unit of measurement for comparison between the Project and Baseline activity (refer to the Project Guidance Document for the Alberta Offset System for more information).
Compost	A solid mature product resulting from composting which is a managed process of bio-oxidation of a solid heterogeneous organic substrate including a thermophilic phase.
Composting	The biological decomposition of organic materials, substances or objects under controlled circumstances to a condition sufficiently stable for nuisance-free storage and for safe use in land application.
Mature Compost	To be considered as mature compost, the material must meet the requirements of CCME for maturity and destruction of pathogenic organisms.
Organic Residue	This includes vegetative matter, food processing waste, landscaping, garden and horticultural wastes, kitchen

scraps, feed processing wastes, and other organic wastes which can be readily composted.

Landfill	A landfill is a site at which materials are stored where they can undergo anaerobic decomposition. This may include the materials being buried, piled, mixed with other waste materials, or otherwise. Landfills, classified as either controlled or uncontrolled, are included in this definition. The designation of controlled or uncontrolled refers to the level of permitting and technical controls in place at the disposal site. Uncontrolled landfills may exist where although there is no expressly stated goal to leave the materials in place, there is a track record of material residing in that place for extended periods (greater than 10 years) and there are no plans or regulatory requirements for the material to be transferred to another disposal site.

2.0 QUANTIFICATION DEVELOPMENT AND JUSTIFICATION

The following sections outline the quantification development and justification.

2.1 Identification of Sources and Sinks (SS's) for the Project

SS's were identified for the project by reviewing the seed documents and relevant process flow diagrams. This process confirmed that the SS's in the process flow diagrams covered the full scope of eligible project activities under the protocol.

Based on the process flow diagrams provided in **FIGURE 1.1**, the project SS's were organized into life cycle categories in **FIGURE 2.1**. Descriptions of each of the SS's and their classification as controlled, related or affected are provided in **TABLE 2.1.**

FIGURE 2.1: Project Element Life Cycle Chart

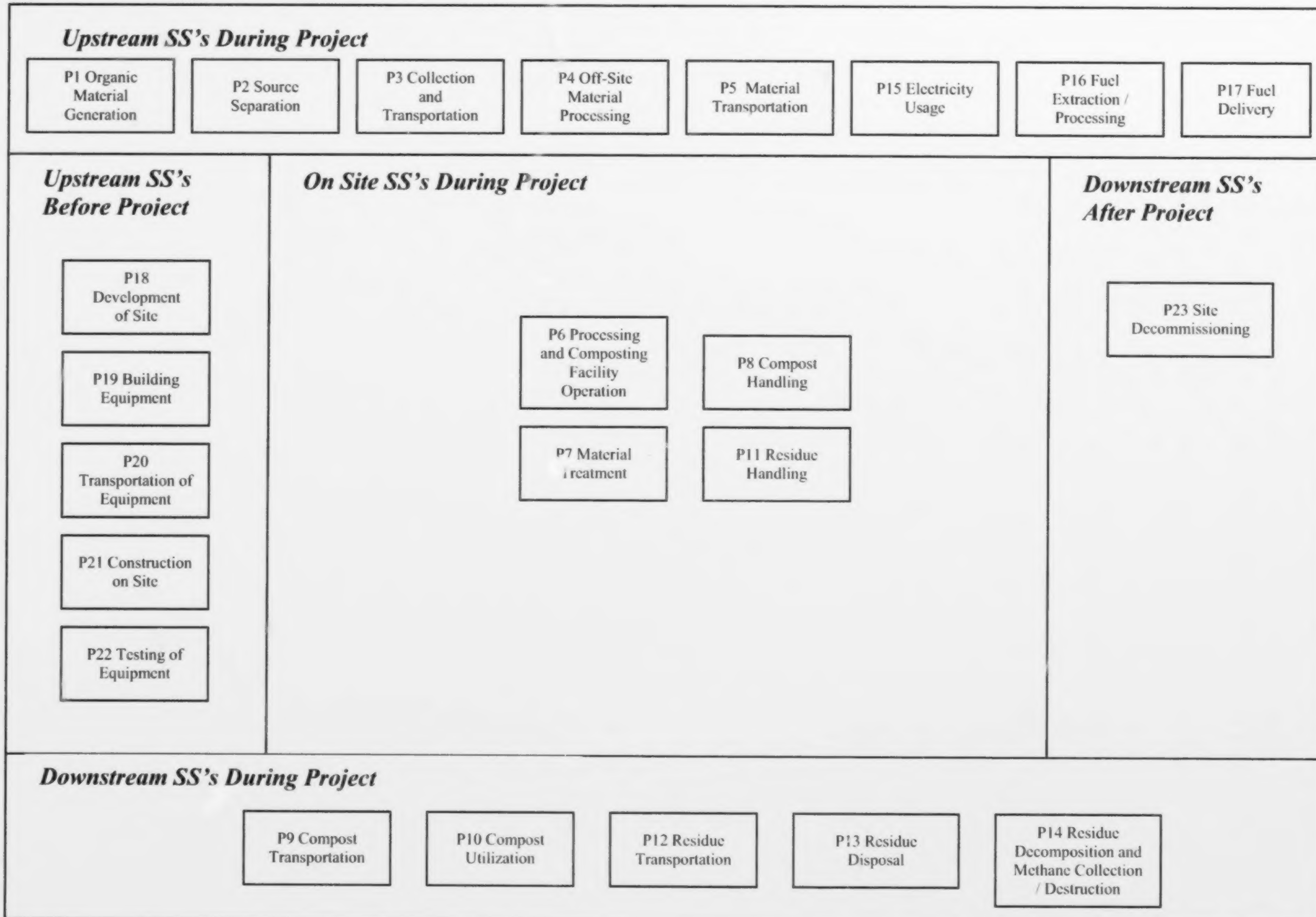


TABLE 2.1: Project SS's

1. SS	2. Description	3. Controlled, Related or Affected
Upstream SS's during Project Operation		
P1 Organic Material Generation	Organic materials are produced in a number ways, depending on the source of these materials. Quantities for each of the energy inputs related to organic materials would be contemplated to evaluate functional equivalence with the baseline condition.	Related
P2 Source Separation	Organic materials may be source separated from other material streams. This is largely a manual process and includes storage of the materials prior to collection and transportation. The related energy inputs for fuelling any equipment used in source separation are captured under this SS, as is the duration and condition of any material storage.	Related
P3 Collection and Transportation	Organic materials may be transported to the project site by truck, barge and/or train. The related energy inputs for fuelling this equipment are captured under this SS, for the purposes of calculating the resulting greenhouse gas emissions. Type of equipment, number of loads and distance travelled would be used to evaluate functional equivalence with the baseline condition.	Related
P4 Off-Site Material Processing	Organic material may be processed using a series of mechanical processes, heavy equipment and conveyors. This equipment would be fuelled by diesel, gasoline, or natural gas resulting in GHG emissions, or electricity. Quantities and types for each of the energy inputs would be tracked.	Related
P5 Transportation	Organic material may be transported to the project site by truck, barge and/or train. The related energy inputs for fuelling this equipment are captured under this SS, for the purposes of calculating the resulting greenhouse gas emissions. Type of equipment, number of loads and distance travelled would be used to evaluate functional equivalence with the baseline condition.	Related
P15 Electricity Usage	Electricity may be required for operating the facility. This power may be sourced either from internal generation, connected facilities or the local electricity grid. Metering of electricity may be netted in terms of the power going to and from the grid. Quantity and source of power are the important characteristics to be tracked as they directly relate to the quantity of greenhouse gas emissions.	Related
P16 Fuel Extraction and Processing	Each of the fuels used throughout the on-site component of the project will need to sourced and processed. This will allow for the calculation of the greenhouse gas emissions from the various processes involved in the production, refinement and storage of the fuels. The total volumes of fuel for each of the on-site SS's are considered under this SS. Volumes and types of fuels are the important characteristics to be tracked.	Related
P17 Fuel Delivery	Each of the fuels used throughout the on-site component of the project will need to be transported to the site. This may include shipments by tanker or by pipeline, resulting in the emissions of greenhouse gases. It is reasonable to exclude fuel sourced by taking equipment to an existing commercial fuelling station as the fuel used to take the equipment to the site is captured under other SS's and there is no other delivery.	Related

Onsite SS's during Project Operation		
P6 Processing and Composting Facility Operation	Organic materials may be processed using a series of mechanical processes, heavy equipment and conveyors. Greenhouse gas emissions may occur that are associated with the operation and maintenance of the aerobic composting facility operations. This may include running vehicles and facilities at the project site. Quantities and types for each of the energy inputs would be tracked.	Controlled
P7 Material Treatment	Various treatment processes for the aerobic composting of the organic materials may be implemented to achieve a desired quality of end-product. These processes may also generate emissions of non-biogenic greenhouse gases. The operating parameter and energy inputs would be tracked.	Controlled
P8 Compost Handling	Compost may be handled using a series of mechanical processes, heavy equipment and conveyors. This equipment would be fuelled by diesel, gasoline, or natural gas resulting in GHG emissions, or electricity. Quantities and types for each of the energy inputs would be tracked.	Controlled
P11 Residue Handling	Residues of the composting process may be processed and handled using a series of mechanical processes, heavy equipment and conveyors. This equipment would be fuelled by diesel, gasoline, or natural gas resulting in GHG emissions, or electricity. Quantities and types for each of the energy inputs would be tracked.	Controlled
Downstream SS's during Project Operation		
P9 Compost Transportation	Compost may be transported from the project site by truck, barge and/or train. The related energy inputs for fuelling this equipment are captured under this SS, for the purposes of calculating the resulting greenhouse gas emissions. Type of equipment, number of loads and distance travelled would need to be tracked.	Related
P10 Compost Utilization	Compost can be used in many applications depending on the quantity produced and the quality of the product including: agriculture, horticulture, landscaping, home gardening, erosion control, roadside landscaping, landfill cover and/or in land reclamation projects. Carbon will be sequestered in the compost. There may be emissions of methane and nitrous oxide. The parameters of compost composition would need to be monitored.	Related
P12 Residue Transportation	Residues may be transported from the project site by truck, barge and/or train to disposal or re-processing sites. The related energy inputs for fuelling this equipment are captured under this SS, for the purposes of calculating the resulting greenhouse gas emissions. Type of equipment, number of loads and distance travelled would need to be tracked.	Related
P13 Residue Disposal	Residue may be handled at a disposal site by transferring the waste from the transportation container, spreading, burying, processing, and otherwise dealing with the waste using a combination of loaders, conveyors and other mechanized devices. This equipment would be fuelled by diesel, gasoline or natural gas, resulting in GHG emissions. Other fuels may also be used in some rare cases. Quantities and types for each of the energy inputs may need to be tracked.	Related

P14 Residue Decomposition and Methane Collection / Destruction	Waste may decompose in the disposal facility (typically a landfill site) resulting in the production of methane. A methane collection and destruction system may be in place at the disposal site. If such a system is active in the area of the landfill where this waste is being disposed, then this methane collection must be accounted for in a reasonable manner. Disposal site characteristics and mass disposed of at each site may need to be tracked as well as the characteristics of the methane collection and destruction system.	Related
Other		
P18 Development of Site	The site of the aerobic composting facility may need to be developed. This could include civil infrastructure such as access to electricity, gas and water supply, as well as sewer etc. This may also include clearing, grading, building access roads, etc. There will also need to be some building of structures for the facility such as storage areas, storm water drainage, offices, vent stacks, firefighting water storage lagoons, etc., as well as structures to enclose, support and house the equipment. Greenhouse gas emissions would be primarily attributed to the use of fossil fuels and electricity used to power equipment required to develop the site such as graders, backhoes, trenching machines, etc.	Related
P19 Building Equipment	Equipment may need to be built either on-site or off-site. This includes all of the components of the storage, handling, processing, combustion, air quality control, system control and safety systems. These may be sourced as pre-made standard equipment or custom built to specification. Greenhouse gas emissions would be primarily attributed to the use of fossil fuels and electricity used to power equipment for the extraction of the raw materials, processing, fabricating and assembly.	Related
P20 Transportation of Equipment	Equipment built off-site and the materials to build equipment on-site, will all need to be delivered to the site. Transportation may be completed by truck, barge and/or train. Greenhouse gas emissions would be primarily attributed to the use of fossil fuels to power the equipment delivering the equipment to the site.	Related
P21 Construction on Site	The process of construction at the site will require a variety of heavy equipment, smaller power tools, cranes and generators. The operation of this equipment will have associated greenhouse gas emission from the use of fossil fuels and electricity.	Related
P22 Testing of Equipment	Equipment may need to be tested to ensure that it is operational. This may result in running the equipment using test anaerobic digestion fuels or fossil fuels in order to ensure that the equipment runs properly. These activities will result in greenhouse gas emissions associated with the combustion of fossil fuels and the use of electricity.	Related
P23 Site Decommissioning	Once the facility is no longer operational, the site may need to be decommissioned. This may involve the disassembly of the equipment, demolition of on-site structures, disposal of some materials, environmental restoration, re-grading, planting or seeding, and transportation of materials off-site. Greenhouse gas emissions would be primarily attributed to the use of fossil fuels and electricity used to power equipment required to decommission the site.	Related

2.2 Identification of Baseline

The baseline condition for projects applying this protocol is the disposal of the organic materials in a landfill (controlled or uncontrolled) where anaerobic decomposition would typically occur. A broad variety of organic materials are considered, including agricultural and agri-food residues, the organic portion of municipal solid waste, food wastes, forestry and landscaping wastes, etc. These materials may be collected and handled as part of an on- or off-site waste management system.

The approach to quantifying the baseline will be projection-based as there are suitable models for the applicable baseline condition that can provide reasonable certainty. The projection-based baseline scenario for this protocol is dynamic as the emissions profile for the baseline activities would be expected to change materially relative to the mass of material composted.

The baseline condition is defined, including the relevant SS's and processes, as shown in **FIGURE 1.2**. More detail on each of these SS's is provided in Section 2.3, below.

2.3 Identification of SS's for the Baseline

Based on the process flow diagrams provided in **FIGURE 1.2**, the project SS's were organized into life cycle categories in **FIGURE 2.2**. Descriptions of each of the SS's and their classification as either 'controlled', 'related' or 'affected' is provided in **TABLE 2.2.**

FIGURE 2.2: Baseline Element Life Cycle Chart

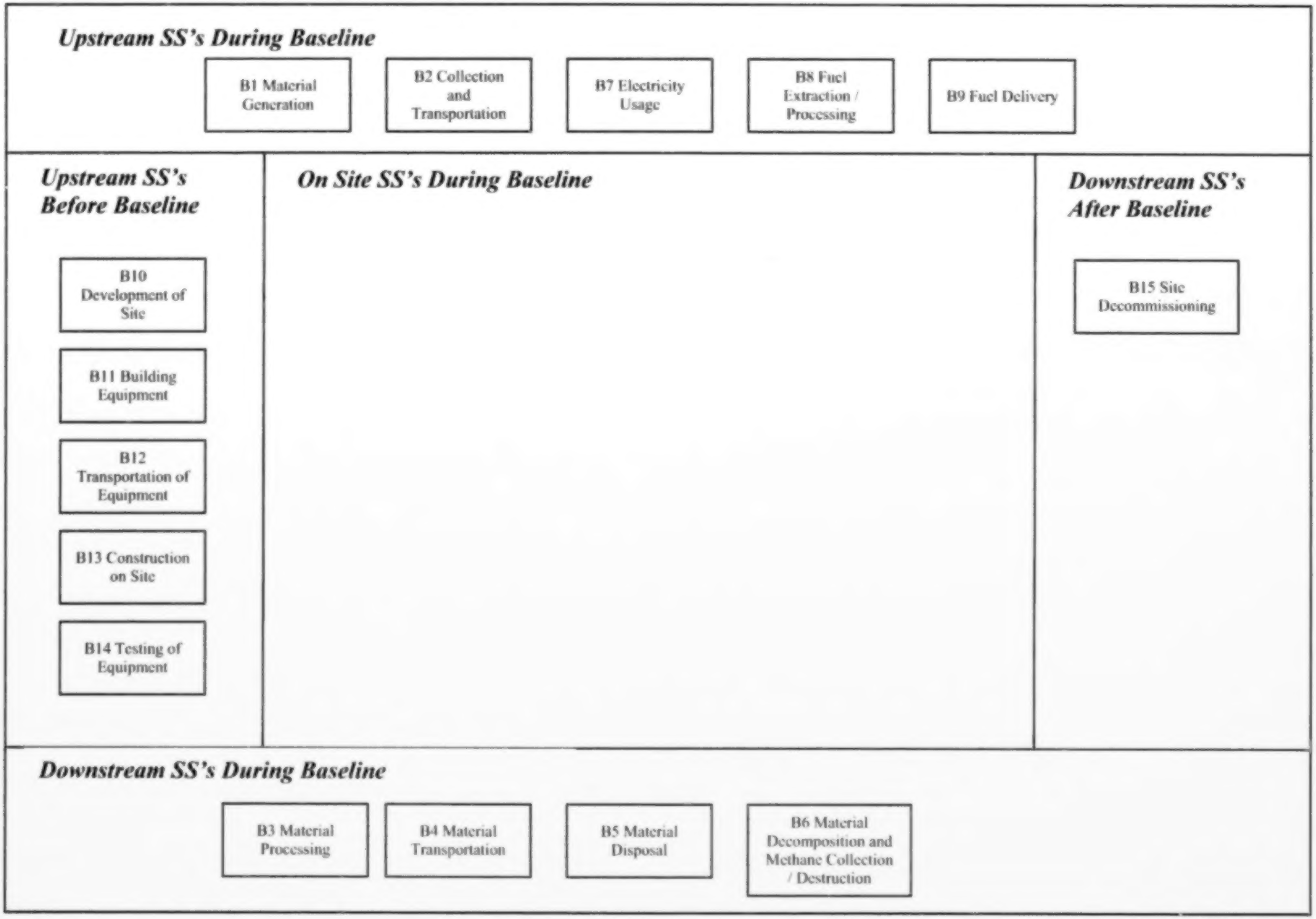


TABLE 2.2: Baseline SS's

1. SS	2. Description	3. Controlled, Related or Affected
Upstream SS's during Baseline Operation		
B1 Material Generation	Organic materials are produced in a number ways, depending on the source of these materials. Quantities for each of the energy inputs related to the organic materials would be contemplated to evaluate functional equivalence with the project condition.	Related
B2 Collection and Transportation	Materials may be transported to the baseline site by truck, barge and/or train. The related energy inputs for fuelling this equipment are captured under this SS, for the purposes of calculating the resulting greenhouse gas emissions. Type of equipment, number of loads and distance travelled would be used to evaluate functional equivalence with the project condition.	Related
B7 Electricity Usage	Electricity may be required for operating the baseline facility. This power may be sourced either from internal generation, connected facilities or the local electricity grid. Metering of electriciiy may be netted in terms of the power going to and from the grid. Quantity and source of power are the important characteristics to be tracked as they directly relate to the quantity of greenhouse gas emissions.	Related
B8 Fuel Extraction and Processing	Each of the fuels used throughout the on-site component of the project will need to sourced and processed. This will allow for the calculation of the greenhouse gas emissions from the various processes involved in the production, refinement and storage of the fuels. The total volumes of fuel for each of the on-site SS's are considered under this SS. Volumes and types of fuels are the important characteristics to be tracked.	Related
B9 Fuel Delivery	Each of the fuels used throughout the on-site component of the project will need to be transported to the site. This may include shipments by tanker or by pipeline, resulting in the emissions of greenhouse gases. It is reasonable to exclude fuel sourced by taking equipment to an existing commercial fuelling station as the fuel used to take the equipment to the site is captured under other SS's and there is no other delivery.	Related
Onsite SS's during Baseline Operation		
	None	
Downstream SS's during Baseline Operation		
B3 Material Processing	Materials may be processed using a series of mechanical processes, heavy equipment and conveyors. This equipment would be fuelled by diesel, gasoline, or natural gas resulting in GHG emissions, or electricity. Quantities and types for each of the energy inputs would be tracked.	Related
B4 Material Transportation	Materials may be transported by truck, barge and/or train to disposal or re-processing sites. The related energy inputs for fuelling this equipment are captured under this SS, for the purposes of calculating the resulting greenhouse gas emissions. Type of equipment, number of loads and distance travelled would need to be tracked.	Related
B5 Material Disposal	Residue may be handled at a disposal site by transferring the material from the transportation container, spreading, burying, processing, otherwise handling the residue using a combination of loaders, conveyors and other mechanized devices. This equipment would be fuelled by diesel, gasoline or natural gas, resulting in GHG emissions. Other fuels may also be used in some rare cases. Quantities and types for each of the energy inputs may need to be tracked.	Related

B6 Material Decomposition and Methane Collection / Destruction	Residues may decompose in the disposal facility (typically a landfill site) resulting in the production of methane. A methane collection and destruction system may be in place at the disposal site. If such a system is active in the area of the landfill where this material is being disposed, then this methane collection must be accounted for in a reasonable manner. Disposal site characteristics and mass disposed of at each site may need to be tracked as well as the characteristics of the methane collection and destruction system.	Related
Other		
B10 Development of Site	The site of the material processing and disposal facilities may need to be developed. This could include civil infrastructure such as access to electricity, gas and water supply, as well as sewer etc. This may also include clearing, grading, building access roads, etc. There will also need to be some building of structures for the facility such as storage areas, storm water drainage, offices, vent stacks, firefighting water storage lagoons, etc., as well as structures to enclose, support and house the equipment. Greenhouse gas emissions would be primarily attributed to the use of fossil fuels and electricity used to power equipment required to develop the site such as graders, backhoes, trenching machines, etc.	Related
B11 Building Equipment	Equipment may need to be built either on-site or off-site. This includes all of the components of the storage, handling, processing, combustion, air quality control, system control and safety systems. These may be sourced as pre-made standard equipment or custom built to specification. Greenhouse gas emissions would be primarily attributed to the use of fossil fuels and electricity used to power equipment for the extraction of the raw materials, processing, fabricating and assembly.	Related
B12 Transportation of Equipment	Equipment built off-site and the materials to build equipment on-site, will all need to be delivered to the site. Transportation may be completed by train, truck, by some combination, or even by courier. Greenhouse gas emissions would be primarily attributed to the use of fossil fuels to power the equipment delivering the equipment to the site.	Related
B13 Construction on Site	The process of construction at the site will require a variety of heavy equipment, smaller power tools, cranes and generators. The operation of this equipment will have associated greenhouse gas emission from the use of fossil fuels and electricity.	Related
B14 Testing of Equipment	Equipment may need to be tested to ensure that it is operational. This may result in running the equipment using test anaerobic digestion fuels or fossil fuels in order to ensure that the equipment runs properly. These activities will result in greenhouse gas emissions associated with the combustion of fossil fuels and the use of electricity.	Related
B15 Site Decommissioning	Once the facility is no longer operational, the site may need to be decommissioned. This may involve the disassembly of the equipment, demolition of on-site structures, disposal of some materials, environmental restoration, re-grading, planting or seeding, and transportation of materials off-site. Greenhouse gas emissions would be primarily attributed to the use of fossil fuels and electricity used to power equipment required to decommission the site.	Related

2.4 Selection of Relevant Project and Baseline SS's

Each of the SS's from the project and baseline condition were compared and evaluated as to their relevancy using the guidance provided in Annex VI of the "Guide to Quantification Methodologies and Protocols: Draft", dated March 2006 (Environment Canada). The justification for the exclusion or conditions upon which SS's may be excluded is provided in **TABLE 2.3** below. All other SS's listed previously are included.

TABLE 2.3: Comparison of SS's

1. Identified SS	2. Baseline (C, R, A)	3. Project (C, R, A)	4. Include or Exclude from Quantification	5. Justification for Exclusion
Upstream SS's				
P1 Organic Residue Generation	N/A	Related	Exclude	Excluded as the generation of residues is not impacted by the implementation of the project and as such the baseline and project conditions will be functionally equivalent.
B1 Residue Generation	Related	N/A	Exclude	
P2 Source Separation	N/A	Related	Exclude	Excluded as this is a manual process with negligible related emissions of greenhouse gases.
P3 Collection and Transportation	N/A	Related	Exclude	Excluded as the emissions from transportation are likely functionally equivalent to the baseline scenario.
B2 Collection and Transportation	Related	N/A	Exclude	
P4 Off-Site Residue Processing	N/A	Related	Exclude	Excluded as the emissions from off-site processing are a component of an integrated waste management plan and would therefore be functionally equivalent to the baseline scenario.
P5 Transportation	N/A	Related	Exclude	Excluded as the emissions from transportation are likely functionally equivalent to the baseline scenario.
P15 Electricity Usage	N/A	Related	Exclude	Excluded as these SS's are not relevant to the project as the emissions from these practises are covered under proposed greenhouse gas regulations.
B7 Electricity Usage	Related	N/A	Exclude	
P16 Fuel Extraction / Processing	N/A	Related	**Include**	N/A
B8 Fuel Extraction / Processing	Related	N/A	Exclude	Excluded as there is no fossil fuel usage being considered in the baseline and these emissions are therefore not relevant to the project.
P17 Fuel Delivery	N/A	Related	Exclude	Excluded as these SS's are not relevant to the project as the emissions from these practises are covered under proposed greenhouse gas regulations.
B9 Fuel Delivery	Related	N/A	Exclude	
Onsite SS's				
P6 Processing and Composting Facility Operation	N/A	Controlled	**Include**	N/A
P7 Material Treatment	N/A	Controlled	**Include**	N/A
P8 Compost Handling	N/A	Controlled	Exclude	Excluded as emissions under this SS are included in P6 Processing and Composting Facility Operation as these processes are typically part of the integrated site operations.
P11 Residue Handling	N/A	Controlled	Exclude	

Downstream SS's				
B3 Residue Processing	Related	N/A	Exclude	Excluded as emissions are only in baseline condition and thus would only serve to increase the quantity of emission reductions achieved. As these emissions are difficult to calculate with any certainty, it is conservative to exclude them.
P9 Compost Transportation	N/A	Related	Exclude	Excluded as the emissions from transportation are likely functionally equivalent to the baseline scenario.
P10 Compost Utilization	N/A	Related	Exclude	Excluded as the sequestration of carbon is difficult to quantify without knowing the end-point for the compost. Further, the emissions of methane and nitrous oxide are negligible given the standard of compost required under the protocol.
P12 Residue Transportation	N/A	Related	Exclude	Excluded as the emissions from transportation are likely functionally equivalent to the baseline scenario.
B4 Residue Transportation	Related	N/A	Exclude	
P13 Residue Disposal	N/A	Related	Exclude	Excluded as the emissions from residue disposal operations are likely functionally equivalent to the baseline scenario.
B5 Material Disposal	Related	N/A	Exclude	
P14 Residue Decomposition and Methane Collection / Destruction	N/A	Related	**Include**	N/A
B6 Material Decomposition and Methane Collection / Destruction	Related	N/A	**Include**	N/A
Other				
P18 Development of Site	N/A	Related	Exclude	Emissions from site development are not material given the long project life, and the minimal site development typically required.
B10 Development of Site	Related	N/A	Exclude	Emissions from site development are not material for the baseline condition given the minimal site development typically required.
P19 Building Equipment	N/A	Related	Exclude	Emissions from building equipment are not material given the long project life, and the minimal building equipment typically required.
B11 Building Equipment	Related	N/A	Exclude	Emissions from building equipment are not material for the baseline condition given the minimal building equipment typically required.
P20 Transportation of Equipment	N/A	Related	Exclude	Emissions from transportation of equipment are not material given the long project life, and the minimal transportation of equipment typically required.
B12 Transportation of Equipment	Related	N/A	Exclude	Emissions from transportation of equipment are not material for the baseline condition given the minimal transportation of equipment typically required.
P21 Construction on Site	N/A	Related	Exclude	Emissions from construction on site are not material given the long project life, and the minimal construction on site typically required.

B13 Construction on Site	Related	N/A	Exclude	Emissions from construction on site are not material for the baseline condition given the minimal construction on site typically required.
P22 Testing of Equipment	N/A	Related	Exclude	Emissions from testing of equipment are not material given the long project life, and the minimal testing of equipment typically required.
B14 Testing of Equipment	Related	N/A	Exclude	Emissions from testing of equipment are not material for the baseline condition given the minimal testing of equipment typically required.
P23 Site Decommissioning	N/A	Related	Exclude	Emissions from decommissioning are not material given the long project life, and the minimal decommissioning typically required.
B15 Site Decommissioning	Related	N/A	Exclude	Emissions from decommissioning are not material for the baseline condition given the minimal decommissioning typically required.

2.5 Quantification of Reductions, Removals and Reversals of Relevant SS's

2.5.1 Quantification Approaches

Quantification of the reductions, removals and reversals of relevant SS's for each of the greenhouse gases will be completed using the methodologies outlined in **TABLE 2.4**, below. A listing of relevant emission factors is provided in **Appendixes A, B and C**. These calculation methodologies serve to complete the following three equations for calculating the emission reductions from the comparison of the baseline and project conditions.

$$\boxed{\text{Emission Reduction} = \text{Emissions}_{\text{Baseline}} - \text{Emissions}_{\text{Project}}}$$

$$\boxed{\text{Emissions}_{\text{Baseline}} = \text{Emissions}_{\text{Decomposition and Methane Collection / Destruction}}}$$

$$\boxed{\begin{aligned}\text{Emissions}_{\text{Project}} = {} & \text{Emissions}_{\text{Facility Operation}} + \text{Emissions}_{\text{Material Treatment}} \\ & + \text{Emissions}_{\text{Decomposition and Methane Collection / Destruction}} \\ & + \text{Emissions}_{\text{Fuel Extraction and Processing}}\end{aligned}}$$

Where:

$\text{Emissions}_{\text{Baseline}}$ = sum of the emissions under the baseline condition.

$\text{Emissions}_{\text{Decomposition and Methane Collection / Destruction}}$ = emissions under SS B6 Material Decomposition and Methane Collection / Destruction[3]

$\text{Emissions}_{\text{Project}}$ = sum of the emissions under the project condition.

$\text{Emissions}_{\text{Facility Operation}}$ = emissions under SS P6 Processing and Composting Facility Operation

$\text{Emissions}_{\text{Material Treatment}}$ = emissions under SS P7 Material Treatment

$\text{Emissions}_{\text{Decomposition and Methane Collection / Destruction}}$ = emissions under SS P14 Residue Decomposition and Methane Collection / Destruction

$\text{Emissions}_{\text{Fuel Extraction and Processing}}$ = emissions under SS P16 Fuel Extraction and Processing

[3] Note – the adjusted baseline value is a 20% discount from the baseline emissions. This amount is based on an analysis of Statistics Canada's Waste Management Industry survey and other studies by Natural Resources Canada for the Alberta context circa 2002, and represents the amount of waste that was diverted from landfills for composting operations in Alberta at that time.

TABLE 2.4: Quantification Procedures

1.0 Project/ Baseline SS	2. Parameter / Variable	3. Unit	4. Measured / Estimated	5. Method	6. Frequency	7. Justify measurement or estimation and frequency
Project SS's						
P6 Processing and Composting Facility Operation	$Emissions_{Collection\ of\ Biomass} = \sum (Vol.\ Fuel_i * EF\ Fuel_{i\ CO2}); \sum (Vol.\ Fuel_i * EF\ Fuel_{i\ CH4}); \sum (Vol.\ Fuel_i * EF\ Fuel_{i\ N20})$					
	$Emissions_{Collection\ of\ Biomass}$	kg of CO_2 ; CH_4 ; N_2O	N/A	N/A	N/A	Quantity being calculated in aggregate form as fuel use on site.
	Volume of Each Type of Fuel / Vol $Fuel_i$	L, m^3 or other	Measured	Direct metering or reconciliation of volume in storage (including volumes received).	Continuous metering or monthly reconciliation.	Both methods are standard practise. Frequency of metering is highest level possible. Frequency of reconciliation provides for reasonable diligence.
	CO_2 Emissions Factor for Each Type of Fuel / EF $Fuel_{i\ CO2}$	kg CO_2 per L, m^3 or other	Estimated	From Environment Canada reference documents.	Annual	Reference values adjusted annually as part of Environment Canada reporting on Canada's emissions inventory.
	CH_4 Emissions Factor for Each Type of Fuel / EF $Fuel_{i\ CH4}$	kg CH_4 per L, m^3 or other	Estimated	From Environment Canada reference documents.	Annual	Reference values adjusted annually as part of Environment Canada reporting on Canada's emissions inventory.
	N_20 Emissions Factor for Each Type of Fuel / EF $Fuel_{i\ N2O}$	kg N_2O per L, m^3 or other	Estimated	From Environment Canada reference documents.	Annual	Reference values adjusted annually as part of Environment Canada reporting on Canada's emissions inventory.
P7 Material Treatment	$Emissions_{Material\ Treatment} = Mass_{Material\ Composted} * EF_{CH4} - Rec._{CH4}; Mass_{Material\ Composted} * EF_{N2O}$					
	$Emissions_{Material\ Treatment}$	kg of CH_4 ; N_2O	N/A	N/A	N/A	Quantity being calculated.
	Mass of Material Composted (wet) / $Mass_{Material\ Composted}$	kg	Measured	Direct measurement of mass of material composted.	Continuous	May be measured upon receiving at site or prior to input to composting operations. In the case of the former, care must be taken to ensure no material is then diverted from landfill without being accounted for.
	Recovered CH_4 from Compost / $Rec._{CH4}$	kg	Measured	Direct metering.	Annual	Mass of methane collected and destroyed.

	CH_4 Emissions Factor for Composting / EF_{CH4}	kg CH_4 per kg	Estimated	From Environment Canada reference documents.	Annual	Reference values adjusted annually as part of Environment Canada reporting on Canada's emissions inventory.
	N_20 Emissions Factor for Composting / EF_{N2O}	kg N_2O per kg	Estimated	From Environment Canada reference documents.	Annual	Reference values adjusted annually as part of Environment Canada reporting on Canada's emissions inventory.
P14 Residue Decomposition and Methane Collection / Destruction	$Emissions_{Decomposition, Collection and Destruction} = (Mass_{Residue Disposed} * MCF * DOC * DOC_F * F * 16/12) * (1 - R) * (1 - OX)$					
	$Emissions_{Decomposition, Collection and Destruction}$	kg of CH_4	N/A	N/A	N/A	Quantity being calculated.
	Mass of Organic Material Sent for Disposal (wet) / $Mass_{Residue Disposed}$	kg	Measured	Measurement of mass of organic material sent to landfill.	Continuous	May be measured upon departure from the composting site or at the waste disposal site. May require estimation of organic fraction.
	Methane Correction Factor / MCF	-	Estimated	Calculated based on IPCC and Environment Canada guidelines, provided in Appendix A and B.	Annual	Values calculated based on values published by IPCC. Reference values adjusted periodically as part of internal IPCC review of its methodologies.
	Degradable Organic Carbon / DOC	-	Estimated	Calculated based on IPCC and Environment Canada guidelines, provided in Appendix A and B.	Annual	Values calculated based on values published by IPCC. Reference values adjusted periodically as part of internal IPCC review of its methodologies.
	Fraction of Degradable Organic Carbon Dissimilated / DOC_F	-	Estimated	Calculated based on IPCC and Environment Canada guidelines, provided in Appendix A and B.	Annual	Values calculated based on values published by IPCC. Reference values adjusted periodically as part of internal IPCC review of its methodologies.
	Fraction of CH_4 in Landfill Gas / F	-	Estimated	From IPCC guidelines.	Annual	Reference values adjusted periodically as part of internal IPCC review of its methodologies.
	Recovered CH_4 at Landfill / R	kg of CH_4	Measured	Direct metering.	Annual	Mass of methane collected and destroyed.
	Oxidation Factor / OX	-	Estimated	From IPCC guidelines.	Annual	Reference values adjusted periodically as part of internal IPCC review of its methodologies.

P16 Fuel Extraction and Processing	$Emissions_{Fuel\ Extraction\ /\ Processing} = \sum (Vol.\ Fuel_i * EF\ Fuel_{i\ CO2})\ ;\ \sum (Vol.\ Fuel_i * EF\ Fuel_{i\ CH4})\ ;\ \sum (Vol.\ Fuel_i * EF\ Fuel_{i\ N2O})$					
	$Emissions_{Fuel\ Extraction\ /\ Processing}$	kg of CO_2e	N/A	N/A	N/A	Quantity being calculated in aggregate form as fuel and electricity use on site is likely aggregated for each of these SS's.
	Volume of Each Fuel Combusted for P1 and P2 / $Vol_{Fuel\ i}$	m^3	Measured	Direct metering or reconciliation of volume in storage (including volumes received).	Continuous metering or monthly reconciliation.	Both methods are standard practice. Frequency of metering is highest level possible. Frequency of reconciliation provides for reasonable diligence.
	CO_2 Emissions Factor for Fuel Production and Processing / EF $Fuel_{i\ CO2}$	kg CO_2 per m^3	Estimated	From Environment Canada reference documents. Provided in Appendix D.	Annual	Reference values adjusted annually as part of Environment Canada reporting on Canada's emissions inventory.
	CH_4 Emissions Factor for Fuel Including Production and Processing / EF_i $Fuel_{CH4}$	kg CH_4 per m^3	Estimated	From Environment Canada reference documents. Provided in Appendix D.	Annual	Reference values adjusted annually as part of Environment Canada reporting on Canada's emissions inventory.
	N_20 Emissions Factor for Fuel Including Production and Processing / EF $Fuel_{i\ N2O}$	kg N_2O per m^3	Estimated	From Environment Canada reference documents. Provided in Appendix D.	Annual	Reference values adjusted annually as part of Environment Canada reporting on Canada's emissions inventory.
Baseline SS's						
B6 Material Decomposition and Methane Collection / Destruction	$Emissions_{Decomposition,\ Collection\ and\ Destruction} = (Mass_{Diverted} * \%_{disposed} * MCF * DOC * DOC_F * F * 16/12) * (1-R) * (1-OX)$					
	$Emissions_{Decomposition,\ Collection\ and\ Destruction}$	kg of CH_4	N/A	N/A	N/A	Quantity being calculated.
	Mass of Material diverted from landfill / $Mass_{Diverted}$	kg	Measured	Equivalent to the mass of material composted in the project condition. Direct measurement of mass of material composted.	Continuous	May be measured upon receiving at site or prior to input to composting operations. In the case of the former, care must be taken to ensure no material is then diverted from landfill without being accounted for.

	% of waste disposed in landfill / $\%_{disposed}$	%	Estimated	Adjusted baseline value set at 80% which represents the portion of waste disposed in landfill in Alberta circa 2002. Note that this value was determined based on the portion of organic waste diverted for composting in Alberta circa 2002.	Annual	Calculated based on an analysis of values published by the StatsCan Waste Management Industry Survey and NRCan.
	Methane Correction Factor / MCF	-	Estimated	Calculated based on IPCC and Environment Canada guidelines, provided in Appendix A and B.	Annual	Values calculated based on values published by IPCC. Reference values adjusted periodically as part of internal IPCC review of its methodologies.
	Degradable Organic Carbon / DOC	-	Estimated	Calculated based on IPCC and Environment Canada guidelines, provided in Appendix A and B.	Annual	Values calculated based on values published by IPCC. Reference values adjusted periodically as part of internal IPCC review of its methodologies.
	Fraction of Degradable Organic Carbon Dissimilated / DOC_F	-	Estimated	Calculated based on IPCC and Environment Canada guidelines, provided in Appendix A and B.	Annual	Values calculated based on values published by IPCC. Reference values adjusted periodically as part of internal IPCC review of its methodologies.
	Fraction of CH_4 in Landfill Gas / F	-	Estimated	From IPCC guidelines.	Annual	Reference values adjusted periodically as part of internal IPCC review of its methodologies.
	Recovered CH_4 at Landfill / R	kg of CH_4	Measured	Direct metering.	Annual	Mass of methane collected and destroyed.
	Oxidation Factor / OX	-	Estimated	From IPCC guidelines.	Annual	Reference values adjusted periodically as part of internal IPCC review of its methodologies.

2.5.2. Contingent Data Approaches

Contingent means for calculating or estimating the required data for the equations outlined in section 2.5.1 are summarized in **TABLE 2.5**, below.

2.6 Management of Data Quality

In general, data quality management must include sufficient data capture such that the mass and energy balances may be easily performed with the need for minimal assumptions and use of contingency procedures. The data should be of sufficient quality to fulfill the quantification requirements and be substantiated by company records for the purpose of verification.

The project proponent shall establish and apply quality management procedures to manage data and information. Written procedures should be established for each measurement task outlining responsibility, timing and record location requirements. The greater the rigour of the management system for the data, the more easily an audit will be to conduct for the project.

2.6.1 Record Keeping

Record keeping practises should include:

a. Electronic recording of values of logged primary parameters for each measurement interval;
b. Printing of monthly back-up hard copies of all logged data;
c. Written logs of operations and maintenance of the project system including notation of all shut-downs, start-ups and process adjustments;
d. Retention of copies of logs and all logged data for a period of 7 years; and
e. Keeping all records available for review by a verification body.

2.6.1 Quality Assurance/Quality Control (QA/QC)

QA/QC can also be applied to add confidence that all measurements and calculations have been made correctly. These include, but are not limited to:

a. Protecting monitoring equipment (sealed meters and data loggers);
b. Protecting records of monitored data (hard copy and electronic storage);
c. Checking data integrity on a regular and periodic basis (manual assessment, comparing redundant metered data, and detection of outstanding data/records);
d. Comparing current estimates with previous estimates as a 'reality check';
e. Provide sufficient training to operators to perform maintenance and calibration of monitoring devices;
f. Establish minimum experience and requirements for operators in charge of project and monitoring; and
g. Performing recalculations to make sure no mathematical errors have been made.

TABLE 2.5: Contingent Data Collection Procedures

1.0 Project/Baseline SS	2. Parameter / Variable	3. Unit	4. Measured / Estimated	5. Contingency Method	6. Frequency	7. Justify measurement or estimation and frequency
Project SS's						
P6 Processing and Composting Facility Operation	Volume of Each Type of Fuel / Vol Fuel $_i$	L, m^3 or other	Measured	Reconciliation of volume of fuel purchased within given time period.	Monthly	Provides reasonable estimate of the parameter, when the more accurate and precise method cannot be used.
P7 Material Treatment	Mass of Material Composted (wet) / Mass $_{Material\ Composted}$	kg	Estimated	Reconciliation with mass of material diverted from disposal sites minus the mass of residue sent for disposal.	Continuous	Provides reasonable estimate of the parameter, when the more accurate and precise method cannot be used.
P14 Residue Decomposition and Methane Collection / Destruction	Mass of Organic Material Sent for Disposal (wet) / Mass $_{Residue\ Disposed}$	kg	Estimated	Reconciliation with billing for material disposed of at disposal sites.	Continuous	Provides reasonable estimate of the parameter, when the more accurate and precise method cannot be used.
Baseline SS's						
B6 Residue Decomposition and Methane Collection / Destruction	Mass of Material diverted from Landfill/ Mass $_{Diverted}$	kg	Estimated	Reconciliation with mass of material diverted from disposal sites minus the mass of residue sent for disposal.	Continuous	Provides reasonable estimate of the parameter, when the more accurate and precise method cannot be used.

APPENDIX A:

Calculation of DOC

Calculation of DOC

The following calculations were conducted according to the information outlined in the "National Inventory Report – Greenhouse Gas Sources and Sinks in Canada, 1990-2004", Environment Canada, April 2006.

Estimates of the degradable organic carbon (DOC) present in a waste stream can be calculated using the following equation:

$$L_0 = MCF * DOC * DOC_F * F * 16/12 * 1000 \text{ kg } CH_4/\text{t } CH_4$$

Where:
- L_O = CH_4 generation potential (kg CH_4/ t waste)
- MCF = CH_4 correction factor (fraction)
- DOC = degradable organic carbon (t C/t waste)
- DOC_F = fraction DOC dissimilated
- F = fraction CH_4 in landfill gas
- 16/12 = stoichiometric factor

According to the IPCC Guidelines, the MCF for managed landfill sites has a value of 1.0. The fraction of CH_4 (F) emitted from a landfill ranges from 0.4 to 0.6 and was assumed to be 0.5. The IPCC default DOC_F value of 0.77 was used. The DOC values in the following table were calculated using average Lo values for each province published by Environment Canada (2006).

TABLE A1: Estimates of DOC by Province

Province	Lo (value after 1990)	DOC (calculated)
British Columbia	108.8	0.21
Alberta	100.0	0.19
Saskatchewan	106.8	0.21
Manitoba	92.4	0.18
Ontario	90.3	0.18
Quebec	127.8	0.25
New Brunswick	117.0	0.23
Prince Edward Island	117.0	0.23
Nova Scotia	89.8	0.17
Newfoundland and Labrador	102.2	0.20
Northwest Territories and Nunavut	117.0	0.23
Yukon	117.0	0.23

APPENDIX B:

Parameters for Use in Calculations Based on Diversion from Landfills by Landfill Type

TABLE B1: Landfill Type-Based Factors

Parameter	Mixed-Waste Landfills				Wood Waste Landfills
	Managed	Unmanaged – Deep (>= 5m waste)	Unmanaged – Shallow (< 5m waste)	Uncategorized	
Methane Correction Factor (MCF)	1.0	0.8	0.4	0.6	0.8[a]
Fraction of CH_4 in landfill gas (F)	0.5				
Fraction of degradable organic carbon dissimilated (DOC_F)	0.77				0.5
Fraction of degradable organic carbon (DOC)	See Appendix A				0.3

a - the default condition for a wood waste landfill is an unmanaged, deep landfill (Environment Canada, 2006). This parameter may be changed if the emissions are being calculated for an alternate type of wood waste landfill.

APPENDIX C:
Relevant Emission Factors

Emission factors for composting are taken from 2006 IPCC Guidelines for National Greenhouse Gas Inventories: Table 4.1. Emissions of CO2 from the composting of biomass are considered biogenic and are therefore not considered.

Table C1: Emission Factors from Composting

Material Composting		
Emissions Factor (CH_4)	0.004	kg CH_4 per kg
Emissions Factor (N_2O)	0.0003	kg N_2O per kg

All values below interpreted from volume 1 of the technical report: A National Inventory of Greenhouse Gas (GHG), Criteria Air Contaminant (CAC) and Hydrogen Sulphide (H2S) Emissions by the Upstream Oil and Gas Industry dated September 2004 completed by Clearstone Engineering Ltd. on behalf of the Canadian Association of Petroleum Producers (CAPP).

Table C2: Emission Intensity of Fuel Extraction and Production (Diesel, Natural Gas, and Gasoline)

Diesel		
Production		
Emissions Factor (CO_2)	0.138	kg CO_2 per Litre
Emissions Factor (CH_4)	0.0109	kg CH_4 per Litre
Emissions Factor (N_2O)	0.000004	kg N_2O per Litre
Natural Gas		
Extraction		
Emissions Factor (CO_2)	0.043	kg CO_2 per m^3
Emissions Factor (CH_4)	0.0023	kg CH_4 per m^3
Emissions Factor (N_2O)	0.000004	kg N_2O per m^3
Processing		
Emissions Factor (CO_2)	0.090	kg CO_2 per m^3
Emissions Factor (CH_4)	0.0003	kg CH_4 per m^3
Emissions Factor (N_2O)	0.000003	kg N_2O per m^3
Gasoline		
Production		
Emissions Factor (CO_2)	0.138	kg CO_2 per Litre
Emissions Factor (CH_4)	0.0109	kg CH_4 per Litre
Emissions Factor (N_2O)	0.000004	kg N_2O per Litre

Table C3: Emission Intensity of Combustion (Diesel, Natural Gas and Gasoline)

Diesel		
Emissions Factor (CO_2)	2.730	kg CO_2 per Litre
Emissions Factor (CH_4)	0.000133	kg CH_4 per Litre
Emissions Factor (N_2O)	0.0004	kg N_2O per Litre
Natural Gas		
Electric Utilities		
Emissions Factor (CO_2)	1.891	kg CO_2 per m^3
Emissions Factor (CH_4)	0.00049	kg CH_4 per m^3
Emissions Factor (N_2O)	0.000049	kg N_2O per m^3
Gasoline		
Electric Utilities		
Emissions Factor (CO_2)	2.830	kg CO_2 per Litre
Emissions Factor (CH_4)	0.00018	kg CH_4 per Litre
Emissions Factor (N_2O)	0.000031	kg N_2O per Litre